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ABSTRACT

Metacognitive activities were studied through the verbalizations of students during a learning process, to study the differences in the performance of good and poor students. The moment of verbalization, either at prompting marks or without prompts, and the instruction in verbalization, either directed or non-directed, were variables. Thirty-two girls and 32 boys in the first year of Dutch comprehensive school, half good performers and half poor performers according to school records, participated. Half were instructed to verbalize only at marks occurring during the learning of lists of English vocabulary words and Dutch translations; half were to verbalize throughout the learning process. Half received directed instruction and half did not. Thinking-aloud protocols were tape-recorded and analyzed. Analyses of variance indicated that the two variables "moment of verbalization" and "instruction" did not have any effect on performance. Both variables also had no effect on the total quantity of verbalization. Most students, however, could not restrict themselves to verbalizing only at the marking points, and most verbalized between marks as well. To keep verbalizations focused on the task, instruction was helpful. Good students apparently interrupted their recalling action during learning by checking and noting their own accuracy more often than did poor students. Six tables present study data. (SLD)

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REGISTRATION OF SELF-REGULATION PROCESSES WITH FIRST YEAR STUDENTS OF A HAVO-VWO COMPREHENSIVE SCHOOL BY MEANS OF THINKING ALOUD

Frank P. C. M. de Jong

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REGISTRATION OF SELF-REGULATION PROCESSES WITH FIRST YEAR STUDENTS OF A HAVO-VWO COMPREHENSIVE SCHOOL BY MEANS OF THINKING ALOUD

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1. Introduction

Although a lot of research on individual difference in metacognition makes use of verbal reports, most are still "measurements at long distance call" with a lot of noise on the line. It is rare that verbal reports consist of on-line thinking aloud during learning. Instead of on-line registration one is trying to get insight in childrens' metacognition by derivations of thinking aloud, for example by asking children which strategies they would use in hypothetical situations (Kreutzer, Leonard, Flavell, 1975; Trepanier, 1981) or by predicting their memoryspan (Yussen and Levy, 1978; Flavell, Friederichs and Hoyt, 1970; Markman, 1973). Another frequently used verbal report is of the retrospective kind. It is on these retrospective protocols that Nisbett and Wilson (1977) ground their conclusion that verbal reports "may not interrogate memorization of the cognitive processes that operated between stimulus and response but a lot of theorizing about the causal connections between stimulus and response" (p. 233).
Such noise or discrepancies between verbal reports and what people actually do or think is inherent in verbalizing, which takes place before or after the task and not during the task. Ericsson and Simon (1980) conclude that if people do not have to retrieve information from other sources than their short-term memory, there is no question of epiphenomenality. Studies on problem solving (Duncker, 1935; De Groot, 1946; Newell and Simon, 1972; Elshout, 1976; Breuker, 1981; Vermunt, 1984) have shown that thinking aloud is an excellent method for research on higher cognitive processes. But it is especially the development of self-report models (Ericsson and Simon, 1980; Elshout, 1976; Breuker, 1981) that lifted the thinking-aloud method out of its banishment from the scientific scene.
But even if you decide on the basis of these powerful theoretical substructures to use thinking aloud as registration method of metacognitive processes, you will be faced with questions concerning the creation of circumstances under which people easily verbalize, and which have their impact on the efficiency of the protocols and their analysis as well. This is important because it still takes up an incredibly great deal of time.
In order to dam the time devouring work of protocol analyses it is realistic to put foreward the question if it is necessary that people express

all their thoughts if a researcher is interested in a part of the verbalizing. What is the relevance of registrating that somebody has a party in the afternoon? Not only from the efficiency point of view it might be better to instruct people in such a way they only express relevant thoughts, but also for the sake of clarity towards people. With a more directed instruction it is easier for people to understand what is asked by thinking aloud. Because of this clarity it might even be that verbalizations are stimulated.

Stimulations are important because not everybody is an easy talker and it serves the researcher to have rich protocols.

From the same point of view it is suggested (Olshavsky, 1976/77) to put marks in a text. But it is still the question if such remembering points have a stimulating or restraining influence on verbalizations when people have to learn vocabulary.

To answer this question, an experiment was conducted in which the moment of verbalization (marks/no marks) and the instruction (directed/non directed) of what to verbalize were manipulated.

However, the first interest of the study concerns the question: What is the difference in the equipment between good and poor students that makes good students be better performers?

A lot of studies (Flavell, 1979; Flavell, Wellman, 1977; Brown, Deloache, 1978; Brown, Palinscar, Armbruster, 1984; Brown, Armbruster, Baker, 1986) show a difference in the metacognition. Training metacognitive activities (Brown et al., 1980; Palinscar, Brown, 1983) also shows to have a great influence on the performances of poor students. This suggests that metacognition is a more critical variable in this matter than strategy deficiency. Therefore metacognitive activities were registrated on tape by the method of thinking aloud and Student Level was manipulated.

2. Procedure

32 girls and 32 boys, of whom one half were "good" and one half were "poor" performers according to admission criteria of their schools and their performance on a national examination, participated in the experiment. Students were trained in thinking aloud during learning - or "learning aloud" - in two introductory sessions. During these sessions half of the students were instructed to verbalize everything they thought of during learning, and the other half were instructed to verbalize only those thoughts which were related to self-regulating activities. Both groups got a list of 44 examples of thought expressions which were related to self-regulation.

The list that was given to the students of this first group (who were told

to verbalize everything) was extended with 17 thought expressions that were not related to selfregulation activities.

In the week after the introductory sessions each student had two learning sessions on two different days, in which they got exactly 15 minutes to learn a list of 40 English words and their Dutch translations. Before each learning session the students were told that after the learning session they had to give the Dutch translation of 20 English words, randomly extracted from the learning task, and the English translation of the 20 Dutch words, (that remained from the learning task). Furthermore they were reminded of what they had to verbalize. They were instructed wether they had to try to learn aloud constantly or only when they encountered a marking- point in the vocabulary list. Each learning session started with listening to the pronunciation of the English words which were recorded on tape.

The variable Instruction (directed/non directed) was a between subjects factor and assigned to a subject during the total experiment. Good and poor performers were counterbalanced over the variable Instruction as was the variable boys/girls. Because the variable "Moment of Verbalization" (thinking aloud at marking points or constantly) was a within variable, two parallel vocabulary lists were necessary, which were counterbalanced over the variable Moments of Verbalization. The order of presentation of the two vocabulary-lists as well as the order of presentation of the two levels of the variable Moment of Verbalization were counterbalanced over subjects.

The thinking-aloud protocols were recorded on tape, typed out literally and analyzed into meaningful units (Wouters and de Jong, 1982). Every meaningful unit contains one process and is not restricted to the limits of a sentence. These meaningful units have been analyzed in five general categories: transforming, orientation, monitoring, directing and testing. Each category consists of several operations . Another category, stimulation, deals with the experimentor's stimulating remarks to verbalize and other remarks by the experimentor and student.

The process analyzing scheme is a modification of the scheme which is developed by Vermunt, Lodewijks and Simons (1986). Modifications are based on analyzed protocols of a pilot study as well as on the first analyzed protocols of the study in question.

3. Results

Data were first subjected to some analyses of variance which concerned a checking of the used counterbalancing. There was no significant effect on the learning achievement of the students that resulted from the order of

presentation of the two vocabulary lists. Whether a list of words contained marks or no marks had also no significant effect on the students' learning achievements. Secondly, MANOVAs were carried out to determine whether the achievement differed systematically between the conditions Marks and No Marks. The factors in these MANOVAs were Instruction, Student Level, Moment of Verbalization and Delay with a repeated measurement on the last two factors. Dependent variables were the performance on the four translation tests (from English to Dutch and from Dutch to English). Student Level had a significant main effect ($F(2.59) = 6.59$; $p < 0.05$). Delay also had a significant main effect ($F(2.59) = 82.03$; $p < 0.0001$). The Moment of Verbalization had no main effect on the achievement. There was no main effect of Instruction although some univariate analyses showed a significant effect. A close look at the means (see table 1), however, shows an unsystematically crossed effect. There were no significant interactions.

Instruction	First test		Retention test	
	E - D	D - E	E - D	D - E
Non-directed	13.20	12.84	10.9	10.29
Directed	14.31	14.22	12.26	11.41
Difference	1.11	1.38	1.36	1.12

Table 1: Performance means of variables Instruction and Delay
(E - D = English - Dutch; D - E = Dutch - English)

Furthermore, two separate series of ANOVAs were carried out with the factors Instruction, Student Level and Delay. One significant interaction between factors Delay and Student Level was found concerning the variable Translating English into Dutch under the condition No Marks ($F(7.60) = 4.49$; $p < 0.04$) of the variable Moment of Verbalization.

After these analyses which concerned the impact of the experimental variables on students' performance an ANOVA was conducted to determine the conditional effects on the total amount of verbalizations. Factors in this ANOVA were Instruction, Student Level and Moment of Verbalization with a repeated measurement on the last factor. Student Level had a significant effect on the amount of verbalization ($F(1.60) = 9.02$; $p < 0.004$).

In order to determine systematical effects of conditions on the amount of verbalized processes, when these were divided into the six analyzing cate-

gories, a MANOVA was conducted with the factors Instruction, Student Level, Moment of Verbalization and the categories Transforming, Orientation, Monitoring, Directing, Testing and Stimulating as variates. The factor Moment of Verbalization was treated as a repeated measurement. Student- Level ($F(6.55) = 5.67$; $p< 0.0001$) and Moment of Verbalization ($F(6.55= 5.13$; $p< 0.003$) had significant main effects.

When we look at the univariate analyses concerning the factor Student Level there were significant effects on the variates Monitoring ($F(1.60)= 12.97$; $p< 0.0006$); Testing ($F(1.60)= 20.47$; $p< 0.0001$) and Stimulating ($F(4.60)= 4.60$; $p< 0.04$). (For means see table 2).

Categories	Student Level		Moment of Verbalization	
	good	poor	no marks	marks
Transforming	32.6	30.6	34.9	28.3
Orientation	2.4	1.8	2.0	2.2
Monitoring	40.7	24.7*	33.2	32.2
Directing	17.3	14.4	16.5	15.1
Testing	33.2	19.1*	29.9	22.4*
Stimulating	6.5	10.4	5.9	10.9*

Table 2: Means per category for the factors Student Level and Moment of Verbalization

* Significant difference between condition levels according to Bonferoni adjustments

When we look to the univariate analyses concerning the within factor Moment of Verbalization, there were significant effects on the variates Transforming ($F(1.60)= 7.41$; $p< 0.01$); Testing ($F(1.60)= 12.04$; $p< 0.001$) and Stimulating ($F(1.60)= 15.45$; $p< 0.0002$). (For means see table 2).

Instruction had no significant effect on the amount of verbalized processes. There were no significant overall interactions. Only the interaction between Moment of Verbalization and Instruction in the univariate analysis

for the variate Orientation was significant ($F(1.60) = 5.78$; $p < 0.02$). Cell means are given in table 3.

Instruction	No marks	Marks
Non-directed	2.9	1.5
Directed	1.2	2.9

Table 3: Cell means for the factor Instruction and Moment of Verbalization concerning the category "Orientation"

A MANOVA with the factors Instruction, Student-Level, Moment of Verbalization as within factor, and the subdivisions of the category Stimulating as variates was carried out to examin which interventions or interruptions had taken place most and under which condition. Only Moment of Verbalization had a significant main effect ($F(5.56) = 3.92$; $p < 0.005$).
A further inspection of the univariate analyses (see table 4) established that only for the variate General Remarks no effect of Marks or No Marks was found. Significantly more stimulation took place when students learned a list with marks.

Variables	No marks	Marks	df	F	p
remarks experiment	1.6	3.2	1.60	7.88	0.0067*
gen. remarks subj.	0.1	0.2	1.60	0.48	0.4920
stim. to verbalize	2.8	4.9	1.60	14.90	0.0003*
questions subject	0.3	0.9	1.60	10.48	0.0020*
reactions subject	1.0	1.8	1.60	4.24	0.0439

Table 4: Means and F-values for the variates of the category "Stimulation" for the conditions No Marks and Marks
* Significant effects according to Bonferoni adjustment

There was also a significant overall interaction between the within factor

and Student Level ($F(5.56) = 4.99$; $p < 0.001$).
Of the univariate interaction between Moment of Verbalization and Student Level there was only a significant interaction for the variate Stimulations to Verbalize ($F(1.60) = 10.32$; $p < 0.003$).
A close look at the means (see table 5) shows that especially good students needed more stimulations in the Marks condition.

Student Level	No marks	Marks
Good	1.8	5.6
Poor	3.8	4.2

Table 5: Cell means of Stimulation to Verbalize for the factor Moment of Verbalization

As mentioned before, Student Level and Moment of Verbalization had main effects on the five process categories in which the analyzed processes were placed. If we view the univariate analysis, the factor Student Level had significant effects on the categories Monitoring ($F(1.60) = 12.97$; $p < 0.001$), and Testing ($F(1.60) = 20.47$; $p < 0.0001$).
In order to get more insight into the differences between the processes that took place during learning with the two Student Level groups, two MANOVAs for each level of the factor Moment of Verbalization were carried out. The factor in these MANOVAs was Student Level and the variates were the processes of the category Monitoring or Testing.
In both of the conditions No Marks and Marks means differed significantly for good and poor students for the processes "noting of a negative inter-result", "noting of a positive inter- result" and "recalling". (see table 6).

Condition	Process category	Processes	mean stud.lev. good	mean stud.lev. poor	F	Df	p
No marks	Monitoring	noting a pos. inter-result	14.5	5.7	12.56	1.60	0.0394
		noting a neg. inter-result	19.8	10.1	13.50	1.60	0.0005*
	Testing	recalling	28.6	16.8	12.27	1.60	0.0009*
		recalling and writing	2.4	0.1	5.43	1.60	0.0231
		correction	2.3	1.4	4.70	1.60	0.0341
Marks	Monitoring	noting a neg. inter-result	13.6	6.2	7.14	1.60	0.00097
		noting a pos. inter-result	16.0	10.0	6.66	1.60	0.0123
	Testing	recalling	22.0	12.2	10.98	1.60	0.0016*

Table 6: Significant mean differences between good and poor Student Level for the categories "Monitoring" and "Testing"
* Significant according to Bonferoni adjustment

4. Discussion and conclusion

Taking the results of the analyses concerning the experimental variables "Moment of Verbalization" and "Instruction" together, it is clear that the two experimental variables "Instruction" and "Moment of Verbalization" do not have any effect on the performance. Both variables have no effect on the total quantity of verbalizations, either. However a more detailed analysis of the data reveals some differences for the two levels of the variable "Moment of Verbalization". The amount of stimulations which are necessary to remind students to verbalize their thoughts in the condition Marks is striking. Add to this that most students could not restrict them-

selves to verbalize only at the marking points. It frustrated them to interrupt their learning at the marks. So almost all students automatically verbalize their thoughts during the time between two marks as well. The real difference between the two conditions No Marks and Marks is that students had to verbalize at marks, and stimulations to verbalize were only given when a mark was encountered.

As students found it more natural to think aloud constantly, and because less interruptions of the learning process were necessary and because the verbalizations that took place under the condition No Marks were certainly not fewer or inferior, it is this situation which has the preference.

If remarks like "it is very hot here today" are not of interest, it is preferable to give a more generally directed instruction in which students are not pinned down in what to say but are given an impression of what is intended by the term thinking-aloud.

The results concerning the difference between good and poor students conform to the findings of Simons, Vermunt, Lodewijks (1985). They also found great differences in monitoring and testing activities between good and poor students.

However, it is not so that the results can be interpreted in this way that good students recall more than poor students, but their recalling activity during learning is more often interrupted by activities of checking and noting whether the words they recalled were correct or incorrect. In other words: good students keep much more an eye on the results of their learning process by checking whether they know the learned words or not.

Another striking thing is that orientation as to how many words and what words had to be learned in such a short time, hardly took place. Also hardly any adaptations took place of one's study strategy to the remained study time. Finally it is remarkable that there is no difference in transforming activities between the groups of poor and good students.